STATE OF ILLINOIS

ILLINOIS COMMERCE COMMISSION

Commonwealth Edison Company	)	
	)	ICC Docket No. 06-0617
	)	
Proposed Revisions to Rate BES-H	)	
Basic Electric Service	)	
Hourly Energy Pricing	)	

DIRECT TESTIMONY OF LYNNE KIESLING ON BEHALF OF THE CITIZENS UTILITY BOARD AND THE CITY OF CHICAGO

CUB-CITY EXHIBIT 2.0

OCTOBER 30, 2006

DIRECT TESTIMONY OF
LYNNE KIESLING

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The Benefits of Dynamic Retail Electricity Pricing: Theory and Evidence

I. BACKGROUND AND PROFESSIONAL EXPERIENCE

Q: PLEASE STATE YOUR NAME, TITLE AND BUSINESS ADDRESS.

A. My name is L. Lynne Kiesling. I am a Senior Lecturer in the Department of Economics at Northwestern University. My business address is 2001 Sheridan Road, Evanston, Illinois 60208 (lkiesling@northwestern.edu). I am appearing in this proceeding as a consultant to the Citizens Utility Board and the City of Chicago.

Q: PLEASE DESCRIBE YOUR PROFESSIONAL EXPERIENCE.

A. Among the other qualifications summarized in my curriculum vitae (attached as Exhibit 2.1), I have been Director of the Center for Applied Energy Research, Interdisciplinary Center for Economic Science at George Mason University. Vernon L. Smith, who received the Nobel Prize in economics in 2002, and I started the center in 2003.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A. I received a B.S. in Economics from Miami University, Oxford, Ohio, in 1987, and a Ph.D. in Economics from Northwestern University in 1993.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am testifying on behalf of the Citizens Utility Board and the City of Chicago.

II. PURPOSE OF THE TESTIMONY AND BACKGROUND

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

My testimony provides the economic theory that explains why dynamic pricing options, such as real time pricing, provide economic benefits to customers and helps to create efficient markets. It also establishes a framework for the role of enabling technology in maximizing the benefits of full participation in such programs. Finally it provides a summary of the evidence from similar programs and experiments from elsewhere in the United States that demonstrates the range of response in changed energy use from price signals (also known as elasticity of demand) that can be achieved from various program designs and implementations.

Q. WHAT ARE YOUR CONCLUSIONS?

Consumers of all types can and do respond to electricity price signals. Furthermore, consumers have responded to price signals with even the most rudimentary digital technology – a simple interval meter. The three cases I discuss (California Statewide Pricing Pilot, Center for Neighborhood Technology ESPP, and Gulf Power's Good Cents Program), all document a substantial amplification of the demand response due specifically to the technology available to the consumer. Thus, the evidence of consumer response to dynamic pricing presented here offers a lower bound on the type and magnitude of behavior we could expect from consumers empowered with the choice of more sophisticated technology.

Retail electric choice puts more control in the hands of consumers and empowers them to make intelligent energy choices, including the choice to use digital technology to automate their behavior in response to dynamic pricing. In a market with retail electric choice, consumers can choose anything from a traditional fixed price that incorporates an insurance premium to optional full real-time pricing, in which the customer bears the financial risk of price volatility, but could see electricity bills fall by shifting or reducing use.

Transformation of the electric power network requires reconnecting markets through price signals, and one of the most effective means of accomplishing that goal is by harnessing the symbiotic relationship of dynamic pricing and enabling technology.

Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.

Allowing customers to choose dynamic pricing enables both consumers and producers to make better decisions that lead to more efficient outcomes. Over time, dynamic pricing enables customers to pay the lowest feasible costs while enjoying the most possible innovations. In conjunction with the testimony of Bernie Neenan (CUB/City Exhibit 3.0), which provides a quantitative model of the economic benefits of implementing residential real time pricing in the Northern Illinois marketplace, my testimony will help the Commission bring such potential benefits into being. I recommend that the Commission approve the creation of a real time pricing program utilizing ComEd Rate BES-H and the program design recommendation contained in CUB/City witness Christopher Thomas' testimony (CUB/City Exhibit 1.0).

III. THE VALUE OF DYNAMIC PRICING OF ELECTRICITY

Q. PLEASE EXPLAIN HOW ELECTRICITY PRICES VARY OVER TIME.

A. Electric loads follow patterns that vary over the day and the season. The daily variation is generally low (off-peak) demand overnight, a rise in demand in the morning to a shoulder period through the day, a high-demand period in the late afternoon and early evening (exacerbated by air conditioning on hot days), and a return to a lower, shoulder demand in the evening. In the absence of any price variation over the course of the day, this pattern repeats daily. The seasonal dimension depends on whether consumers in the area use electricity for heat or cooling, and the extremity of the area's climate variance.

The cost of generating and distributing electric power service to end-use customers varies over the day and across seasons. The fixed retail rates that customers faced under retail regulation meant that the prices individual consumers pay bear little or no relation to the marginal cost of providing power in any given hour. Facing fixed prices, consumers have no incentive to change their consumption as the marginal cost of producing electricity changes. Furthermore, fixed prices ignore any variation in benefits of electricity use to consumers across time. The consequences of this disconnect among cost, price, and consumption transcend inefficient energy consumption to include inappropriate investment in generation and transmission capacity.

Q. PLEASE DESCRIBE DYNAMIC PRICING AND ITS BENEFITS.

A. Dynamic pricing harnesses the dramatic improvements in information technology of the past twenty years to provide price signals that reflect variations in the actual costs and benefits of providing electricity at different times of the day. These same technological developments also give consumers tools for managing their energy use, which they can do either manually or automatically. Currently, with most U.S. consumers paying average prices, consumers have little incentive to manage their consumption and shift it away from peak hours during the day. That inelastic demand leads to more capital investment in power plants than would occur if consumers could make choices based on their preferences. Static, average pricing also leads to a mismatch between the retail price and the cost of providing power in that hour. This mismatch creates inefficiency through generation resource misallocation. It also creates inequity because off-peak consumers subsidize peak consumers through the higher prices paid during off-peak hours.

Without dynamic pricing, the power system will fail to deliver efficiency and value to consumers. Technological, institutional, regulatory, and cultural changes have created a diversity of products and services that the electricity industry can profitably sell to consumers. Dynamic pricing is necessary to maximize the value of technological innovation and other market reforms that characterize a modern, forward-looking power system; dynamic pricing also is, in and of, itself a valuable step in producing efficient and fair electricity markets.

Q. IS THERE REAL WORLD EVIDENCE OF THE BENEFITS OF DYNAMIC PRICING?

A. Yes. The evidence of the past 20 years suggests that customers respond in a variety of ways and to a variety of degrees to dynamic pricing, even when using only rudimentary enabling technology. Most existing programs and studies focus primarily on consumer behavior in the face of dynamic pricing. However, the focus of study is shifting to the question of the symbiosis of pricing and technology. That is, with the enabling technology now available, do customers respond differently to dynamic pricing? In conjunction with dynamic pricing, the ability of customers to control their electricity consumption using digital technology is at the core of pursuing consumer well-being through a modern, digitally-enabled electric power network.

Q. IS REAL TIME PRICING A FORM OF DYNAMIC PRICING?

A. Yes it is. Several utilities have implemented limited market-based pricing programs. Although small and exploratory, these programs have generated positive results that will be useful as more utilities move to market-based pricing. Almost none of these programs implements true dynamic pricing, though; instead they are "demand response" programs that use time-of-day price changes to give customers incentives to shift load. Nor do most of them explore the full effects of digital enabling technology beyond simple interval meters. However, these programs are still important because they do indicate how powerful price incentives can be for consumers, and how dynamic pricing contributes to a reliable, efficient electricity system.

George and Faruqui[1] define dynamic pricing as "any electricity tariff that recognizes the inherent uncertainty in supply costs." Dynamic pricing can include time-of-use rates, which are different prices for different blocks of time over a day, based on expected wholesale prices. Dynamic pricing can also include real-time pricing ("RTP") in which actual market prices are transmitted to consumers, generally in increments of an hour or less. A time-of-use rate typically applies predetermined prices to specific time periods by day and by season. RTP differs from time-of-use mainly because RTP exposes consumers to unexpected variations (positive and negative) due to demand conditions, weather, and other factors. In a sense, fixed retail rates and RTP are the endpoints of a continuum of how much price variability the consumer sees, and different types of time-of-use systems are points on that continuum. Thus, RTP is but one example of dynamic pricing. Both RTP and time-of-use provide better price signals to customers than current average prices do. They also enable companies to sell, and customers to purchase, electric power service as a differentiated product.

Q. HOW DO ENABLING TECHNOLOGY AND DYNAMIC PRICING INTERACT?

A. Dynamic pricing and the digital technology that enables communication of price information are symbiotic. Dynamic pricing without enabling technology is meaningless; technology without economic signals to which to respond is extremely limited in its ability to coordinate buyers and sellers in a way that optimizes network quality and resource use. The combination of dynamic pricing and enabling technology changes the

[1] George, Stephen, and Ahmad Faruqui. "The Economic Value of Market-based pricing for Small Consumers," presentation to the California Energy Commission, March 2002. P. 2.

value proposition to the consumer from “I flip the switch and the light comes on” to a more diverse and consumer-focused set of value-added services.

Such diverse value-added services empower consumers and enable them to control their electricity choices with more granularity and precision than the current environment, in which they think solely of the total amount of electricity they consume. Whether it is a building control system that enables the consumer to see the amount of power used by each function performed in the building, or an appliance that can be automated to change its behavior based on changes in the retail price of electricity, these products and services provide customers an opportunity to make better choices with more precision than ever before. In aggregate, these choices lead to better capacity utilization, better fuel resource utilization, and provide incentives for innovation to meet their needs and capture their imaginations.

Q. HOW DO MARKET PROCESSES COORDINATE DECENTRALIZED DECISIONS?

A. In market processes, prices communicate valuable information about seller costs and buyer values. This information does not only determine resource allocation in a static, snapshot sense; it also determines the levels and types of investments and innovations that occur over time. Those investments and innovations can change the nature and quality of the network as a whole, in part by changing the products and services available to consumers.

According to economic theory competitive markets provide powerful incentives for all market participants to act in ways that benefit consumers. In contrast to an environment without dynamic retail pricing and competition, competitive markets empower consumers to reject prices and product offerings that they find unattractive. That power induces producers to innovate in customer-centric ways. The incentives for innovation and efficiency that result from this process have been successful in powering our economy and have given American consumers a standard of living that is the envy of the world. While real time pricing alone will not create a fully competitive market, it is one core component of moving from the current inefficient market design of today to a better design in the future. As Illinois moves into a new era of restructuring in 2007, including substantial rate increases for most customers, a fully competitive market has not yet emerged. For maximum economic efficiency, policies that can promote the development of a competitive marketplace, including the ability for consumers to choose a dynamic pricing option, should be encouraged.

Q. HOW DO ECONOMISTS VALUE THE EFFICIENCY OF MARKETS?

A. When evaluating fixed and dynamic pricing of electricity, economists use two concepts of efficiency – static efficiency and dynamic efficiency. Static efficiency measures the extent to which resources are allocated, produced and consumed efficiently (that is, in ways that maximize total well-being or total surplus) in a short-run snapshot of the transaction. Dynamic efficiency measures the extent to which investment, innovation, and technological change occur that optimizes resource allocation, production and consumption over time.

Q. WHY IS DYNAMIC PRICING IMPORTANT AND BENEFICIAL?

A. Keeping retail prices fixed truncates the information flow between wholesale and retail markets, and leads to inefficiency, price spikes, and price volatility. Fixed retail rates for electric power service mean that the prices individual consumers pay bear little or no relation to the marginal cost of providing power in any given hour. Moreover, because retail prices do not fluctuate, consumers are given no incentive to change their consumption as the marginal cost of producing electricity changes. This severing of incentives leads to inefficient energy consumption and also causes inappropriate investment in generation and transmission capacity. It has also stifled the implementation of technologies that enable customers to make active consumption decisions, even though communication technologies have become ubiquitous, affordable, and user-friendly.

The benefits of implementing dynamic pricing are extensive and widely agreed upon. Dynamic pricing makes the value of their energy use transparent to consumers, and particularly benefits consumers whose consumption is flexible. That flexibility and those responses to price signals leads to market power mitigation, because active demand disciplines the ability of suppliers to raise prices. Consequently, dynamic pricing leads to lower wholesale electricity prices, better capital utilization and load factors, and reduced needs for additional generation and transmission investment. In this way dynamic pricing leads to long-term cost reductions relative to fixed, regulated rates. Dynamic pricing also promotes a more equitable distribution of those costs, because it prioritizes electricity consumption according to value and does a better job of reflecting the actual costs of service.

Q. WILL DYNAMIC PRICING IMPROVE RELIABILITY?

A. Yes. Increased reliability is one particularly valuable benefit of dynamic pricing. Although reliability is traditionally treated as a supply issue, it is also a demand issue. Active demand response to price signals inherently acts to moderate strains on the entire system when that system's use is properly priced. Dynamic pricing and demand response reduce peak-period consumption, thereby reducing strain on the transmission network and decreasing the need for expensive transmission investments. Customer load reduction can serve long-run reliability functions, by reducing the likelihood of transmission bottlenecks and insufficient generation. Reliability in the existing regulated model requires the utility to have (or have access to) sufficient generation capacity to satisfy *all* demand at *all* hours of the day – this high capital requirement is one consequence of the regulated "obligation to serve" aspect of the government-granted monopoly franchise. The requirement to build to meet peak is expensive, but the failure to use dynamic pricing to reduce those peaks makes the capital requirement even higher.

Q. HOW DOES DYNAMIC PRICING PROMOTE TECHNOLOGICAL INNOVATION?

A. One of the most important benefits of dynamic pricing is its promotion of innovation. The transparency of price signals that better reflect the actual cost of power gives consumers incentives to seek out novel products and services that better enable them to manage their own energy choices and make decisions that better meet their needs. This incentive induces entrepreneurs to invest their capital in providing products and services that consumers may choose. Competition for the business of active, engaged, empowered retail customers drives innovation in end-use technologies, such as integrated home gateways that allow homeowners to manage their home theaters, stereos, appliances and heating and cooling.

Q. ARE THERE RISK MANAGEMENT BENEFITS?

A. Yes. Another benefit of dynamic pricing is risk management. Dynamic pricing emphasizes the information content of prices, an aspect of prices that frequently gets overlooked in political debates. Prices communicate valuable information about relative value and relative scarcity, and when buyers and sellers make consumption and production decisions based on those signals, they communicate further information about value and scarcity. This information transmission and aggregation process is at the core of the efficiency of outcomes generated through market processes. An important policy distinction arises between customers being *required* to see hourly prices, and customers having the *opportunity* to see hourly prices. Requiring real-time pricing would both contradict the idea of choice and expose some customers to more price risk than they might choose voluntarily.

Q. ARE CONCERNS ABOUT PRICE VOLATILITY JUSTIFIABLE?

A. No. Concerns about retail price volatility are exaggerated, especially in an environment where suppliers offer a menu of different pricing contracts to their consumers. One of the most valuable benefits of dynamic pricing, but also one of the most underappreciated and least understood, is its insurance aspects. Dynamic prices can provide two types of insurance: financial and physical. Financial insurance is protection against price volatility; physical insurance is protection against quantity volatility, or outage risk. From this point of view, the current regime has too much price insurance, although substantial disagreement exists about the optimal level of physical insurance.

As a wholesale commodity, electricity has volatile prices. The financial insurance benefit of dynamic pricing derives from this inherent volatility. The traditional fixed average rate for electricity has two components – the price of the electricity commodity itself, and the risk premium that consumers pay for being protected from volatile prices. However, given that regulated rates are typically set to approximate long-run average cost, consumers do not always pay a full insurance premium for the extent that they are insured against price volatility. Furthermore, in states that have pursued restructuring, the political bargain usually includes a fixed, discounted retail rate during a multi-year phase-out of price caps. Discounts on historic rates exacerbate the extent to which consumers do not pay a full insurance premium for the protection from price volatility that they enjoy.

Q. DOES DYNAMIC PRICING FOSTER CHOICE?

A. Yes. Dynamic pricing would create an opportunity for consumers to choose how much of that price risk they are willing to bear, and how much they are willing to pay to avoid by laying it off on some other party (such as a retailer). Although regulated rates have provided financial insurance, they do not fully communicate the cost of insuring different types of consumers against different types of price risks. They also fail to reflect the different degrees to which diverse consumers might choose to be insured. Customer heterogeneity means that they have, among other things, different risk preferences, and different willingness to pay to avoid price risk. Dynamic prices allow the electricity commodity price and the financial insurance premium components of the price to be unbundled, and to be offered separately to customers. This unbundling would enable more efficient pricing of the financial risk, leading to better risk allocation. Real time pricing is an example of such a fully unbundled rate structure; other dynamic pricing options like time of use, critical peak pricing and demand bidding provide examples of rates that have various degrees of partial unbundling of this risk.

Quantity volatility, and the associated outage risk, differs from price risk because it is a reliability of service issue that is not often connected with the idea of insurance. This physical insurance characteristic is what creates the opportunity for value in interruptible contracts. Dynamic pricing enables some customers to shift load to off-peak (a form of physical insurance), which can benefit *all* consumers because it would reduce overall prices. Consumers who choose to use meters and face real-time dynamic pricing will provide their own financial insurance, or not, as they choose. But in so doing they may provide a physical spillover benefit to other consumers, by reducing overall peak usage and improving reliability for all, with less excess capacity, and therefore at lower average cost.

Q. IS THIS TOO COMPLICATED FOR RESIDENTIAL CUSTOMERS?

A. No. Critics argue that such risk considerations are too complicated for many customers. Two important arguments address this concern. First, most customers, even residential, have experience buying automobile collision insurance, and many consumers have experience investing through financial markets. Consumers have experience in dealing with risk tradeoffs, because they see this relationship in other contexts, like collision insurance, and different customers have different risk profiles and different risk preferences. Offering them alternatives that capture those differences improves economic efficiency and resource allocation in the industry. For these reasons, if regulators allow customers to choose how much risk to manage and how much to pay to avoid risk, and how to manage those risks, consumers will themselves create physical insurance for the whole system.

Second, the network aspects of the system mean that even if only some large customers find it worthwhile to manage their financial risk, their choice to do so will benefit the system participants more broadly, even those who do not choose to manage their own price risk through a time-of-use rate or RTP contract.

Q. ARE YOU AWARE OF ANY ESTIMATES OF THE VALUE OF ACTIVE DEMAND AND DYNAMIC PRICING?

A. Yes. Several studies have estimated the value of transforming the electric power network to incorporate more active demand and digital technology. A Government Accountability Office study reported estimates of the overall economic value of more active electricity demand and ability to respond to price signals. These estimates of benefits range from $4.5 billion to $15 billion annually.[2]

In 2004, Rand performed an analysis of the benefits of the GridWise Initiative, a national initiative to modernize the electric power network using communication technology, building and appliance automation, market processes, and contracts. The GridWise Initiative emphasized the use of technology to communicate information, including price signals. Thus Rand's estimate of the benefits of GridWise provides evidence on the value of dynamic pricing and enabling technology. Their analysis uses a residential price elasticity of demand of –0.15, which is consistent with the elasticity estimates used in Dr. Neenan's model in his testimony for this proceeding. Projecting estimates forward to 2025, the Rand study compares a phased-in GridWise transition to the Energy Information Administration's Annual Energy Outlook projections over the same period. GridWise features that were modeled include peak load reduction due to dynamic pricing; capacity investment deferral for generation, transmission, and distribution; reduced operating expenses; improved power quality and reliability; and improved efficiency. Rand used ranges of estimates of these variables to arrive at aggregate discounted benefits from $32 billion to $132 billion. Their nominal estimate of the net present value of benefits over 20 years is $81 billion.[3]

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[2] Government Accountability Office. "Electricity Markets: Consumers Could Benefit From Demand Programs, But Challenges Remain," GAO-04-844, August 2004. Available at http://www.gao.gov/new.items/d04844.pdf. Tables 1 and 2.

[3] Walter, B, Fulton F. and S. Mahnovski. Estimating the Benefits of the GridWise Initiative: Phase I Report. RAND Science and Technology for the Pacific Northwest National Laboratory. May, 2004. Pg. 28.

IV. RESULTS OF PREVIOUS DYNAMIC PRICING PROGRAMS

Q. PLEASE SUMMARIZE THE EXPERIENCES OF DYNAMIC PRICING FOR COMMERCIAL AND INDUSTRIAL CUSTOMERS.

A. Utilities have been experimenting with dynamic pricing for large commercial and industrial customers for over 25 years. Larger customers are generally believed to be more willing and able to respond to price signals than smaller customers. In many, but not all, cases, larger customers have building controls and other installed technology networks that enable them to automate electricity price response behavior more readily and at less cost than smaller customers. Studies over the past 25 years demonstrate that this presumption is generally true, but that large customers do vary greatly with respect to their actual responses to dynamic pricing and to the enabling technology they possess and are willing to use to automate behavioral responses.

Aigner and Hirshberg studied heterogeneous small and medium-sized commercial and industrial firms with peak-load pricing in Southern California. They find a "significant though small estimated elasticity of substitution of 0.4433."[4] Elasticity of substitution is another measure of customer responsiveness to price changes. They also found that for the largest customers, their summer responses would have been sufficient to generate enough savings to offset more than the cost of the interval meter required to communicate the price signal to the customer.

[4] Aigner, D., and J. Hirshberg. "Commercial/Industrial Customer Response to Time of Use Prices: Some Experimental Results," Rand Journal of Economics 16 (1985), pp. 341-355. P. 352.

Herriges *et. al.*[5] analyzed a time-of-use rate and a (revenue neutral) real-time rate experiment performed with Niagara Mohawk's large energy customers. Their analysis indicated that in peak hours the real-time price users reduced their consumption by 36 percent, while the control group only reduced their peak use by 5 percent. On the highest priced days, the real-time users decreased their energy use over the entire day, while the control group's use increased. These results provided early evidence that large users do respond to price signals and can both decrease energy demand and shift energy use to non-peak hours. Herriges *et al* also found that responsiveness did vary, even among large users, but that the responses of a few large customers were sufficient to cut peak demand substantially. This result illustrates how nonlinear the system effects of dynamic pricing can be – small changes in individual behavior at the margin can have large effects on other variables like grid stability and wholesale energy prices.

More recently, Georgia Power's real-time pricing pilot program incorporates an innovation in designing retail pricing structures. Over 1,600 commercial and industrial customers with 5,000 total megawatts (an average of 3.1 megawatts per customer) of peak demand participate.[6] Each participating customer has a right to consume the current load profile used in rate calculations for that customer, and any deviations from the load profile are priced with reference to a real-time price. Georgia Power has seen load reductions of 10-20 percent of peak demand for participating customers. Georgia Power

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[5] Herriges, Joseph, Mostafa Baladi, Douglas Caves, and Bernard Neenan. "The Response of Industrial Customers to Electric Rates Based Upon Dynamic Marginal Costs," Review of Economics and Statistics 75 (1993), pp. 446-454.
[6] O'Sheasy, Michael. "Real Time Pricing at Georgia Power Company," Appendix A in Severin Borenstein, Michael Jaske, and Arthur Rosenfeld, "Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets," Center for the Study of Energy Markets Working Paper 105, October 2002. Available at http://repositories.cdlib.org/ucei/csem/CSEMWP-105.

has also observed that its commercial and industrial customers exhibit a wide range of price elasticities of demand when they can act on their preferences.

Q. CAN RESIDENTIAL CUSTOMERS HAVE SIMILAR RESULTS?

A. Yes. Residential customers are generally believed to be less able to change their behavior in response to dynamic pricing, and to be less willing to do so. As with commercial and industrial customers, however, there is considerable heterogeneity within the residential customer class, a heterogeneity that technology and retail entrepreneurs could exploit to provide technologically-interested and early adopter consumers with attractive, novel value propositions. Studies of residential response to dynamic pricing suggest that even without much enabling technology customers do respond to simple price signals; furthermore, when equipped with enabling technology that can include digital home gateways and/or smart, grid-friendly appliances, such technology produces even stronger responses to dynamic pricing.

Q. PLEASE DESCRIBE EARLY EFFORTS TO INTRODUCE DYNAMIC PRICING TO RESIDENTIAL CUSTOMERS.

A. Wisconsin was the pioneer in exploring the use of peak-load pricing to residential customers. Caves and Christensen[7] and Caves, Christensen and Herriges[8] describe a residential peak-load pricing experiment in Wisconsin between 1976 and 1980. Different

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[7] Caves, Douglas, and Laurits Christensen. "Residential Substitution of Offpeak for Peak Electricity Usage under Time-of-Use Pricing," Energy Journal 1 (1980), pp. 85-142.

[8] Caves, Douglas, Laurits Christensen, and Joseph Herriges. "The Neoclassical Model of Consumer Demand with Identically Priced Commodities: An Application to Time-of-Use Electricity Pricing," Rand Journal of Economics 18 (1981), pp. 564-580.

customers had different "slopes" or differences between off-peak and peak rates. Consumers did respond to peak-load pricing by shifting their use. Furthermore, the consumers whose behavior changed the most were those with air conditioners and those with electric water heaters. The price elasticity of demand of these consumers was higher in certain peak hours, and varied across the day, as measured by differences in elasticities of substitution. Caves, Herriges and Keuster[9] performed a similar analysis of Pacific Gas & Electric's time-of-use rate experiment, with similar results.

Q. DID THE ENERGY CRISIS IN CALIFORNIA LEAD TO ANY INNOVATION ON RESIDENTIAL PRICING PROGRAMS?

A. Yes. One brief episode during the California electricity crisis provides further evidence on the extent of customer demand response, even in the absence of advance price signals and enabling technology. By 2000 San Diego Gas & Electric ("SDGE") had recovered its stranded costs and was released from the retail rate cap established by the California Public Utility Commission ("CPUC"). SDGE set its rates to end-use customers based on a five-week moving average of wholesale market prices. Unfortunately, the price of natural gas had risen by then, and much of California's "market" had shifted to the real-time spot market, which raised wholesale prices. SDGE passed these increased costs on to consumers, and in the summer of 2000 most San Diego customers saw their electric rates double. Furthermore, they only saw the effects of the rate increase after the fact, when their bills arrived. Consumers complained, and complained enough to have rate regulation reimposed in September 2000, but they also conserved in response to price

[9] Caves, Douglas, Joseph Herriges, and Kathleen Keuster. "Load Shifting Under Voluntary Residential Time-of-Use Rates," Energy Journal 10 (1989), pp. 83-99.

increases. Bushnell and Mansur estimated that the average price elasticity of demand during the three months before the reimposition of regulated rates was –0.068; in other words, a 100 percent increase in price led to a 6.8 percent decrease in consumption.[10] This event provides some evidence that, although demand for electric power is inelastic, it is indeed downward sloping, and customers can and do respond to price signals.

Q. HAVE THEIR BEEN ADDITIONAL STUDIES IN CALIFORNIA?

A. Yes. California's electricity policy challenges, particularly the absence of active demand to discipline the pricing behavior of suppliers, led to the California Statewide Pricing Pilot ("SPP"). A joint project of the investor-owned utilities, the CPUC, and the California Energy Commission, the SPP tested different pricing structures and how customers responded to them during 18 months between July, 2003 and December, 2004. two thousand five hundred residential and small commercial or industrial customers faced different types of time-of-use price structures, some of which had a critical peak price ("CPP"). All participants faced at least a peak price and an off-peak price, except for one group that received only day-ahead critical period notification, but did not receive price signals. Prices varied seasonally, reflecting the higher cost (and higher value) of providing power during summer months. Participants received digital meters capable of receiving and communicating hourly price signals.

Residential SPP participants faced one of four pricing structures: CPP-F, CPP-V, time-of-use rates, and information only. CPP-F involved a fixed time-of-use structure on all

[10] James Bushnell and Erin Mansur, "Consumption under Noisy Price Signals: A Study of Electricity Retail Rate Deregulation in San Diego," Journal of Industrial Economics 53(4) (December 2005): 493-513.

weekdays, but a critical peak price period could be in effect for up to 15 days per year. Participants would be notified of a CPP period 24 hours in advance, and the CPP price and length of critical peak were fixed. Time-of-use participants faced the same price structure as the CPP-F households, except that they did not receive any CPP notifications. The CPP-V rate varied from the CPP-F rate in three ways: participants would receive notification of a critical period up to four hours in advance instead of 24 hours, the critical peak period they faced could vary from one to five hours, and they had supplemental enabling technology that they could use to manage their responses to price signals.

The SPP final report[11] includes estimates of both the daily own-price elasticity of demand and the elasticity of substitution. For the CPP-F participants, the daily price elasticity in 2003 equaled -0.035, and the 2004 daily price elasticity was –0.054. The elasticity of substitution in 2003 equaled -0.09, and the 2004 elasticity of substitution was –0.086.[12] In other words for a 100% increase in the price of power, usage decreased by as much as nine percent. Average reductions in consumption were highest during the summer months (July, August, September), and the houses with central air conditioning had the largest absolute and percent reduction in consumption. Overall consumption did not decrease, so there was no conservation effect among these participants.

The structure that was closest to real time pricing was CPP-V. CPP-V participants had daily price elasticities ranging between –0.027 and –0.044, and elasticities of substitution

[11] Charles River Associates (CRA). Impact Evaluation of the California Statewide Pricing Pilot. March 2005.

[12] Id. at Pg. 48.

between –0.077 and –0.111; indicating that usage could decline by more than ten percent when prices increased by 100 percent. However, the most important result from the CPP-V analysis is that the use of supplemental enabling technology amplified the impact (i.e., reduction of consumption in response to price signal) relative to that seen in the CPP-F sample. The impact of the group with enabling technology was more than double the average CPP-F impact (27 percent vs. 13 percent).[13] Furthermore, an econometric decomposition of the impact of the CPP-V decisions indicates that 60 percent of the impact was due to the use of the enabling technology, and 40 percent was due to other behavioral responses. This result is the crucial one for showing the potential that digital technology has for increasing the ease of automating decisions for residential customers, and thus for turning active demand into a network resource.

Information-only participants did not create significant reductions in use during critical hours. This result led the SPP analysts to conclude that demand response is unsustainable in the absence of the price signals inherent in dynamic pricing.

Q. ARE YOU AWARE OF THE RESULTS OF OTHER SIMILAR RESIDENTIAL PRICING PROGRAMS?

A. Yes. Gulf Power in Florida (a subsidiary of Southern Company) operates a residential demand response program, based on a combination of metering and control technology, customer service, and a time-of-use pricing structure. Gulf Power's Good Cents Select program uses a four-part time-of-use price structure, a programmable thermostat that allows customers to establish settings based on temperature and price, meter-reading technology, and load control technology for customers to shift load if they chose in response to price signals. Customers also pay a participation fee, which is one unusual feature of the Gulf Power program.

In 2001, 2,300 residences participated in the Good Cents Select program. In that year Gulf Power achieved energy use reductions of 22 percent during high-price periods and 41 percent during critical (usually weather-related) periods. Furthermore, customer satisfaction is 96 percent, the highest satisfaction rating for any Gulf Power program in its history, notwithstanding the monthly participation fee. Customers say that the $4.53 fee (which covers approximately 60 percent of program costs) is worth the energy management and automation benefits that they derive from participating in the program.[14]

The Good Cents Select program is unique in its use of technology to provide residential customers with automation capabilities. Each home has a programmable gateway/interface that, in addition to allowing thermostat programming, enables the customer to program up to four devices in the home to respond to price signals.[15] When surveyed, part of the high customer satisfaction and willingness to pay a monthly participation fee arises from this ability to use technology to manage energy use in the home and increase the ease of making choices in the face of price signals.

[14] Borenstein, Severin, Michael Jaske, and Arthur Rosenfeld. "Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets," Center for the Study of Energy Markets Working Paper 105, October 2002. Available at http://repositories.cdlib.org/ucei/csem/CSEMWP-105. Appendix B.

[15] Government Accountability Office. "Electricity Markets: Consumers Could Benefit From Demand Programs, But Challenges Remain," GAO-04-844, August 2004. Available at http://www.gao.gov/new.items/d04844.pdf. Pg. 9, 42.

Q. ARE YOU FAMILIAR ANY EFFORTS IN ILLINOIS TO PROVIDE DYNAMIC PRICING TO RESIDENTIAL CUSTOMERS?

A. Yes. The Energy-Smart Pricing Plan ("ESPP") is a three-year joint effort between the Center for Neighborhood Technology's Community Energy Cooperative and Commonwealth Edison. In its first year (2003), the program had 750 participants in a variety of neighborhoods and types of homes, from large single-family homes to multiple-unit buildings. In 2004 the program expanded to 1,000 participants, and in 2005 the program had 1,500 participants. It is the only large-scale program that presents residential customers with hourly price signals. Commonwealth Edison provides the hourly prices, on a rate tariff approved by the Illinois Commerce Commission.

The keys to the Energy-Smart Pricing Plan are simplicity and transparency in the transmission of information to residential customers. Participants receive a simple digital interval meter, and can either call a toll-free phone number or visit a website to see what the hourly prices will be on the following day. Furthermore, if the next day's peak prices will exceed 10 cents/kilowatt hour, customers receive a notification by phone, email or fax. Customers will never pay a price above 50 cents/kilowatt hour, which the Community Energy Cooperative implemented by buying a financial hedge at 50 cents.

In 2003, the first year of the program, customers saved an average of 19.6 percent on their energy bills.[16] They generally joined the program expecting to save $10/month on

[16] Summit Blue ESPP 2003 review report (2004). Available at http://www.energycooperative.org/pdf/ESPP-Final-Report.pdf.

average, and were not disappointed. Surveys indicate that the participants found the price information timely, and that with this small inducement to save money on their energy bill by making small behavioral modifications, they actually became more aware of their energy use overall, only in the approximately 30 hours last summer that had higher prices. They also said that their personal contributions toward reduced energy use and improving the environment by participating in this plan really mattered to them.

Although the summer of 2003 was mild in northern Illinois, participants did respond when prices rose. Most residents increased the temperature on their air conditioners or shifted their laundry time to off-peak hours. The econometric analysis of the results showed a price elasticity of demand in those hours, at the margin, of –0.042. In other words, when price rose by 100 percent, participants reduced their electricity use by 4.2 percent. For residential electricity customers, this is a healthy response, particularly given the lack of severe weather conditions. This reduction in use is a reduction at the margin, a margin that can often see prices go up by more than 100 percent in peak hours on hot days. Thus, although the elasticity number may sound low, because it is at the margin and at the right time, it can take strain off of the system and contribute to grid stability and service reliability in those hours. On average, the residents on ESPP reduced their energy use in high price hours by approximately 20 percent, a number similar to the reductions seen in the Gulf Power program.

In 2004, another mild summer in northern Illinois, the price elasticity of demand was –0.08; a 100 percent increase in price led to an 8 percent decrease in consumption at the margin.[17] Again, this number is consistent with those seen in other studies. As in 2003, the price elasticity of demand for multiple-family dwellings with no air conditioning was surprisingly high: -0.117.[18] Fifty-seven of the participants had automation switches added to their air conditioning in 2004 to enable price-triggered air conditioning cycling during high price notifications, but the cool weather and infrequent high price notifications made evaluating this effect difficult. When surveyed, 34 percent of participants said they had replaced a major appliance since joining the program, and almost all of them bought more energy efficient units.[19] These results indicate that even in the presence of cool weather, the dynamic pricing did provide incentives to manage energy use.

The 2005 summer was hot in Illinois, with sustained periods of high electricity prices. Over the entire summer and the total participant pool, the price elasticity of demand at the margin was –0.047; a 100 percent increase in price led to a 4.7 percent decrease in consumption.[20] On the hottest day of the summer, July 25, total electricity consumption by the participants was 15 percent lower than the level of consumption predicted if the participants had not been receiving dynamic price signals. The hot weather led to many hours with high price notifications, and customers did respond to these notifications; in particular, those receiving email notifications responded more than those who received

[17] Summit Blue ESPP 2004 review report (2005). Available at http://www.energycooperative.org/pdf/ESPP-2004-Evaluation-Final-Report.pdf.

[18] Id. at Pg. 10.

[19] Id. at Pg. 35.

[20] Summit Blue ESPP 2005 review report (2006). Available at http://www.energycooperative.org/pdf/ESPP-Evaluation-Final-Report-2005.pdf.

them by telephone. It is unclear whether the form of the notification or selection bias within the participant pool is the main reason for this difference. The frequency of high price notifications did lead to fatigue, or a diminution in response, when the notifications occurred in a row, but responses did rebound as time increased between high price notifications.

The hot weather in 2005 also enabled examination of the effects of the automated air conditioner cycling; the use of automated switches increased the price elasticity of demand for those customers to –0.069, an increase of 0.022 (46 percent) relative to the elasticity for the total participant pool. This result suggests that automation of control can amplify demand response and the various individual and system benefits that derive from it.

This program has received extensive local and national attention because of its careful attention to rate design and its beneficial results from residential populations that were not expected to respond substantially to dynamic pricing. I frequently have cited its results in presentations across the country.

Q. ARE YOU INVOLVED IN ANY RESEARCH EFFORTS ON LINKING DYNAMIC PRICING AND ENABLING TECHNOLOGY?

A. Yes. A current project in the Pacific Northwest promises to provide further evidence on consumer behavior with dynamic pricing and enabling technology. The Pacific Northwest National Laboratory ("PNNL") GridWise Olympic Peninsula Project involves

130 households by presenting them with enabling technology and the opportunity to choose a retail contract from a menu of contracts. The enabling technology is a programmable thermostat with a graphical user interface, a digital meter, and a water heater that can receive digital data, such as a price signal, and be programmed to provide an automated response to that price signal. Participants choose one contract type from the following menu: fixed, RTP, or time-of-use with a critical peak component. This project directly explores the interaction between dynamic pricing and the availability and use of enabling technology to automate decisions. The project began in April 2006 and will continue for one year. My primary role in the project has been responsibility for the menu of contracts from which customers get to choose, and I have also worked on customer marketing and education materials, the user interface in the digital thermostat, and preliminary analysis of data on the behavior of households in the project. The PNNL team took many design ideas and much inspiration from the experience of the Energy Smart Pricing Plan in Illinois.

Q. HAVE YOU SUMMARIZED THE RESULTS OF VARIOUS DYNAMIC PRICING PROGRAMS?

A. Yes. Table 1 summarizes the own-price elasticity, elasticity of substitution, and impact/peak consumption reduction results in the projects discussed above. The range of results and the consistency of some degree of impact across the studies indicate that consumers can and do respond to dynamic pricing, and that installed enabling technology creates the opportunity for them to amplify that response by automating their behavior.

Table 1

Summary of Elasticity and Impact Results

Location	Type of Customer	Study	Year	Own-Price Elasticity	Elasticity of Substitution	Reduction of Peak Consumption
San Diego	Mix	Bushnell & Mansur (2001)	2000	-0.068		
CA CPP-F	Residential	CRA (2005)	2003	-0.035	-0.09	
CA CPP-F	Residential	CRA (2005)	2004	-0.054	-0.086	13% (average)
CA CPP-V	Residential w/technol.	CRA (2005)	2003-2004	-0.027 to -0.044	-0.077 to – 0.111	27% (average)
CA CPP-V	C&I LT20	CRA (2005)	2003-4			14.3%
CA CPP-V	C&I GT20	CRA (2005)	2003-4			13.8%
Gulf Power	Residential	Borenstein et. al. (2002)	2001			22% (high price sig) 41% (weather crit.)
Chicago ESPP	Residential	Summit Blue	2003	-0.042		
Chicago ESPP	Residential	Summit Blue	2004	-0.08		
Chicago ESPP	Residential	Summit Blue	2005	-0.047		
Chicago ESPP	Residential w/AC switch	Summit Blue	2005	-0.069		

The success of such programs for such a heterogeneous variety of customers shows the potential future for active retail choice in electric power. Current "load profiling" practices of public utilities with flat rates lump all consumers into large groups, and charges them similar rates whether they consume on-peak or off. This practice means the more frugal customers end up helping to pay for the most extravagant – a kind of "customer service" that belongs to the past.

V. CONCLUSIONS AND RECOMMENDATIONS

Q. WHAT ARE YOUR CONCLUSIONS?

A. The evidence demonstrates that consumers of all types can and do respond to electricity price signals. Furthermore, consumers have responded to price signals with even the most rudimentary digital technology – a simple interval meter. Evidence of the effect of enabling technology is largely impressionistic, because most studies and projects have focused on demonstrating customer response to price signals and not on the incremental effect of technology. In the three cases discussed here (California Statewide Pricing Pilot, Center for Neighborhood ESPP, Gulf Power Good Cents Program), studies have documented a substantial amplification of the demand response due specifically to the technology available to the consumer. Thus the evidence of consumer response to dynamic pricing presented here offers a lower bound on the type and magnitude of behavior we could expect from consumers empowered with the choice of more sophisticated technology.

One limitation of the programs and pilots that have taken place over the last two decades is their known, finite nature. If customers know that a program is finite, they may behave differently than they would if presented with open-ended retail options. Furthermore, the length of the program may not be sufficiently long to provide a payback to the customer for the change in behavior. The opportunity for the Commission in this proceeding is to set into place a program that is robust, substantial and long-term.

Retail electric choice puts more control in the hands of consumers and empowers them to make intelligent energy choices, including the choice to use digital technology to automate their behavior in response to dynamic pricing. Consumers could choose anything from a fixed price that incorporates an insurance premium to full real-time pricing, in which the customer bears the financial risk of price volatility, but could see electricity bills fall by shifting or reducing use.

The negative consequences of fixing retail rates have been hidden for decades by other aspects of regulation, such as the control of wholesale prices and excess supply in generation, but the problems arising from fixed retail rates have become more obvious in the era of restructuring. In particular, the liberalization of wholesale prices has disconnected the wholesale and retail markets, with unintended negative effects for customers and firms. The transformation of the electric power network requires reconnecting those markets through price signals, and one of the most effective means of accomplishing that goal is by harnessing the symbiotic relationship of dynamic pricing and enabling technology.

Q. WHAT ARE YOUR RECOMMENDATIONS TO THE COMMISSION?

A. Allowing customers to choose dynamic pricing enables both consumers and producers to make better decisions that lead to more efficient outcomes. Over time, dynamic pricing enables customers to pay the lowest feasible costs while enjoying the most possible innovations. In conjunction with the testimony of Bernie Neenan (CUB/City Exhibit 3.0), which provides a modeling of the economic benefits of the implementation of residential real time pricing in the Northern Illinois marketplace, my testimony will help the Commission determine that the potential of such benefits exist. I recommend that the Commission approve the creation of a real time pricing program utilizing ComEd Rate BES-H and the program design recommendation contained in CUB/City witness Christopher Thomas' testimony (CUB/City Exhibit 1.0).

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes it does.